Art. XIV.—*A Contribution to our Knowledge of the Tertiaries in the Neighbourhood of Melbourne.*

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(Plate VIII.)

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Numerous scattered references have been made to the Melbourne Tertiaries in our Geological Literature, but hitherto no attempt has been made to describe them in any detail in the light of the more recent palæontological work that has been published. The lithological character of the sedimentary rocks of the period, consisting as they do, for the most part, of ferruginous sands and gravels, is not suited to the good preservation of fossils which are represented as a rule by casts, and to a lesser extent by usually very friable remains of the fossils themselves. As we have been collecting material and studying the beds in all parts of the area for some years, we feel that we are now in a position to make some substantial additions to the knowledge of the series and to clear away some misconceptions which prevail in reference to their age.

Historical.

We mention in chronological order the more important references to the deposits and the titles of a few additional papers will be found in the Literature at the end of the present article.

In 1855 Mr. A. R. C. Selwyn, (1) under the head of Tertiary, described the lithological character of the beds, indicating four divisions. He says that the blue clays with limestone bands appear to be the lowest portion of the tertiary series exposed in the district; that they are rich in fossils, and that on the whole they bear a striking resemblance to the beds of the London clay and Hampshire basins. He says that in a well sinking at Prahran fossil shells were found in ferruginous sandstone, and also near Flemington overlying basalt. The beds were stated to bear a strong resemblance to the Crag of Suffolk, but the relation between the Flemington beds and those of Brighton was still uncertain. In dealing with the recent estuary beds, he says:—"Between Sandridge and Melbourne these beds have been proved to a depth of fifty feet, by a series of borings recently executed by Mr. Christie. In all the bores he has obtained recent shells, at various depths from the surface to about thirty feet; the accompanying section along the line of borings I have drawn from the data furnished by Mr. Christie, and on examination which he has kindly permitted me to make of the specimens obtained from each bore, at every one or two feet." The section shows tertiary beds under the estuarine series.

In the following year Mr. Wm. Blandowski (2) referred to what are apparently the ferruginous beds of Flemington as belonging to the "uppermost tertiary formation," and stated that the fossils are living species.

In the following year Mr. Selwyn (3) briefly described the localities and lithological character of the tertiary beds of the area indicated by the title of his paper, but made no subdivisions, classing together the consolidated sand dunes of Point Nepean, the ferruginous sands and gravels which are so widely spread, and the blue clays of Mornington. The succession of the beds was shown, the richest fossil localities were indicated and a list of some of the genera was given.

The four geological quarter-sheets, showing the boundaries of the different formations in the neighbourhood of Melbourne, were issued apparently early in 1860, and are indispensable to any one examining the district. The country round Brighton has not yet been surveyed in detail.

In 1872 Mr. R. Brough Smyth (4) summarised the work of the Geological Survey, and gave a table showing the accepted classification of the Victorian tertiaries as they had been from time to time interpreted by Sir Frederick McCoy. The Marine beds of Flemington were referred to the Pliocene, and the white clays underlying the Older Volcanic at Flemington and Kensington to the Miocene, while the Schnapper Point beds were called Oligocene. He gave a section, showing the relations of the beds, from the Royal Park to the escarpment on the left bank of the Saltwater River. The volcanic rock at South Melbourne and West Melbourne is coloured on the quarter-sheets as Lower Volcanic—that is, Lower Newer Volcanic—and is so lettered except on Quarter-sheet 1, N.W., where the lettering is V.O., *i.e.*, Older Volcanic. Mr. Smyth showed that the volcanic rocks of these areas are of the same age as those on the west of the Moonee Ponds Creek, and are all "Older Volcanic." He then clearly described the basin of Port Phillip, pointing out the sequence of the beds accurately ; but it must be borne in mind that the nomenclature is entirely different from that adopted by the authors of the present paper. Another point on which we differ from him is in the interpretation of the sandy beds capping the hill along the south-west front of Royal Park. Mr. Smyth regarded these as sand dunes, but they are, in our opinion, an integral part of the upper series of marine tertiary beds displayed in the railway cutting in Royal Park.

In 1875 Mr. R. Etheridge, jun. (5), incidentally described a cliff section near Mordialloc which had been visited by Aplin and himself some years previously. As to the age of the beds, he simply says that they had been "mapped by Mr. A. R. C. Selwyn as of Pliocene age."

In 1876, and during some succeeding years, Sir Frederick McCoy (6) repeatedly referred to the fossiliferous beds of the Brighton to Mordialloc coast and of Flemington. They were classed together as of Older Pliocene Age.

Some nine years later, Mr. Reginald A. F. Murray consolidated the work of previous observers in Victorian Geology and referred the Flemington and Brighton beds and the gravel of Flagstaff Hill to the Pliocene Age. (7 p. 13).

In 1888, Professor Ralph Tate (8) doubtfully classed the Cheltenham beds as Miocene.

In 1892, one of the present authors (11), acting on the advice Professor Tate, classed the Cheltenham beds as Eocene.

Early in the following year, Mr. T. S. Hart (12) gave the results of prolonged, careful examination of the rocks of the

Brighton coast. The reference to Pliocene age and identity with the Flemington beds was unquestioningly adopted. The rocks were divided lithologically into a fourfold series. The author stated that there is an unconformity in the beds. We have had the pleasure of going over the coast sections in company with Mr. Hart, and have examined some of these unconformities, which undoubtedly exist. The best we have seen exposed is at Red Bluff, Sandringham. We are not, however, inclined to attach much importance to these small local irregularities. The rapid alternations of sediment, the current bedding, and the occurrence of fossil trees, pointed out by Mr. Hart, imply conditions favourable to the deposition and removal of strata, which would produce unconformities, but would not indicate any difference in age. In most places the beds succeed one another with no appreciable break.

In the same year the authors (13) indicated that the Flemington beds were probably Eocene, and definitely referred the blue clays found by sinking and boring at Newport and Altona Bay to the Eocene.

Messrs. Tate and Dennant (15) definitely classed the Cheltenham beds as Eocene, and a few months later Professor Tate (16) again expressed the same view.

Localities.

1. *Beaumaris* (east of the Hotel).

This is the richest fossil locality that is exposed, and is probably the source of most of the fossils recorded from "Cheltenham" and "Mordialloc." A slight anticlinal brings up the deeper beds in which the fossils are most plentiful, the strike being parallel to the coast line. In the northern corner of the bay the eastern limb of the arch suddenly plunges at an angle of from 20° to 25° in the direction E. 25° S. A little further to the south-west the dip decreases somewhat and swings a little more to the southward, being E. 40° S. at 17°, so that the anticline has a slight pitch in a south-westerly direction. The beach floor has long been a favourite collecting ground, and sharks' teeth, cetotolites and fragments of bone were formerly very commonly found. Many years ago it was noticed that these could be obtained *in situ* by sinking a couple of feet at low tide, but the band containing them is not exposed. Loose nodules of limestone occur on the beach mingled with ironstone pebbles, which form a coarse shingle. Many of the limestone nodules contain perfect casts of fossils, which are, as our list shows, all typical Eocene species. We have not spent much time in collecting these forms, and have not recorded any collected from holes sunk on the beach floor, but have confined our attention to the strata which crop out along the base of the cliff. An examination of the fossils obtained from the cliff justifies us in referring the exposed beds to Miocene age. There are a few species of which the range will be thus extended into the Miocene; but if, on the other hand, the beds were regarded as Eocene, a very large number of the most characteristic Miocene fossils would have to be considered as common to both Miocene and Eocene on the evidence of this section alone. The band yielding teeth, bones and ironstone concretions will probably be found to mark the junction of the two formations, the Eocene beds occurring below it.

Some of the fossil bands are fairly rich in mollusca, but they are much decomposed as a rule, and the greatest care is requisite to obtain whole specimens. Still, we have obtained a fair number of species, and quite enough to determine the age of the beds.

The character of the beds, seen in cliff section, has been so carefully described by Mr. Hart (12) that further comment is almost unneccessary. Taken as a whole, they consist of quartzose sand, with a varying amount of argillaceous material, and, excepting near the top of the cliffs, are strongly ferruginous.

The following fossils have been obtained from the cliffs at this locality :—

Crustacea (*Cirripedia*).

? Balanus sp.

Echinodermata.

Lovenia forbesi, Woods and Duncan.

Cidaroid spines.

Zoantharia.

Placotrochus deltoideus, Duncan.

Placotrochus elongatus, Duncan.

Brachiopoda.

Terebratulina catinuliformis ?, Tate.
Magasella compta, G. B. Sowerby.

Lamellibranchiata.

Ostrea arenicola, Tate.
Placunanomia ione, Gray.
Pecten antiaustralis, Tate.
Modiola, n. sp.
Nucula tenisoni, Pritchard.
Nucula, n. sp. aff. N. morundiana, Tate.
Nucula, n. sp.
Leda woodsii, Tate.
Leda vagans, Tate.
Leda acinaciformis, Tate.
Leda, n. sp. aff. L. huttoni, T. Woods.
Leda, n. sp.
Limopsis belcheri, Adams and Reeve.
Pectunculus cainozoicus, T. Woods.
,, laticostatus, Quoy and Gaimard.
Cucullæa corioensis, McCoy.
Trigonia acuticostata, McCoy.
Crassatella, n. sp. aff. C. oblonga, T. Woods.
Crassatella, n. sp. aff. C. abbreviata, Tate.
Carditella polita, Tate.
Cardita calva, Tate.
,, solida, Tate.
,, compacta, Tate.
,, delicatula ?, Tate.
,, n. sp.
,, n. sp.
Lucina aræa ?, Tate.
,, sp.
Diplodonta sp.
Chione subroborata, Tate.
,, n. sp. aff. C. propinqua, T. Woods.
,, n. sp. aff. C. dimorphophylla, Tate.
Dosinia johnstoni, Tate.
Tellina æquilatera, Tate.
,, albinelloides, Tate.

Tellina, n. sp. aff. T. stirlingi, Tate.
Psammobia hamiltonensis, Tate.
Semele krauseana ?, Tate.
Mactra hamiltonensis, Tate.
Zenatiopsis angustata, Tate.
Myadora corrugata, Tate.
Myadora praelonga, Tate.
Corbula ephamilla, Tate.
Barnea tiara, Tate.
Brechites sp.

Gastropoda.

Triton, n. sp.
Voluta, n. sp.
Ancillaria orycta, Tate.
,, n. sp. ?
Harpa, n. sp. aff. H. abbreviata, Tate.
Cassis, n. sp.*
Pelicaria coronata, Tate.
Terebra additoides ?, T. Woods.
Cypraea leptorhyncha, McCoy.
,, n. sp.
Natica varians, Tate.
,, substolida, Tate.
,, subinfundibulum, Tate.
,, hamiltonensis, T. Woods.
Calyptræa crassa, Tate.
Crepidula unguiformis, Lamarck.
Turritella tristira, Tate.
,, acricula, Tate.
,, pagodula, Tate.
Rissoa, sp.
Bankivia maxima, Tate, m.s.
Leiopyrga sayceana, Tate.
Calliostoma, sp.
Cylichna, sp.

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* This species may possibly be the same as that recorded by Professor R. Tate, from Cheltenham, under the name of *Cassis textilis*, Tate. My examination of the shells has, however, inclined my opinion towards regarding the present fossil as specifically distinct from the Murray Cliffs shell.

Scaphopoda.

Entalis mantelli, Zittel.
,, subfissura, Tate.
Dentalium bifrons, Tate.

Pisces.

Carcharodon megalodon, Agassiz.
,, angustidens, Agassiz.
Oxyrhina, sp.
Notidanus, sp.
Lamna, sp.
Myliobates, sp.
Strophodus eocenicus, Tate.
Palate, aff. Diodon.
Vertebræ.
Otoliths.

Mammalia.

Whale, vertebræ, etc.
Cetotolites.

SUMMARY (CHARMAN'S ROAD END).

Crustacea	1
Echinodermata	2
Zoantharia	2
Brachiopoda	2
Lamellibranchiata	45
Gastropoda	24
Scaphopoda	3
Pisces	10
Mammalia	2
	91

In addition to the above, Professor Tate records the following species from Cheltenham :—

Natica subvarians, Tate.
,, polita, T. Woods, forma typica, Tate.
,, perspectiva, Tate.
Pelicaria clathrata, Tate.

Sir Frederick McCoy (6) has recorded the following species from Mordialloc in addition to those above mentioned :—

Pecten yahlensis, T. Woods.
Spondylus pseudoradula, McCoy.
Aturia australis, McCoy.
Physetodon baileyana, McCoy.

These probably came from the neighbourhood of Charman's Road.

2. *Beaumaris* (West of Hotel).

As at the previous locality, the rocks are mainly ferruginous earthy sandstones. In places where the beds are hard, beautifully sharp impressions of shells occur in profusion, while in others calcareous bands full of shells run for long distances. Unfortunately the fossils are very rotten, and it is difficult to obtain specimens which will bear removal. The commonest fossil in the ferruginous beds is *Lovenia forbesi*, which occurs in enormous numbers in a beautiful state of preservation.

Foraminifera.

Echinodermata.

† Ortholophus lineatus, Duncan (Temnechinus).
† Clypeaster gippslandicus, McCoy.
† Monostychia australis, Laube, forma loveni, Duncan.
Lovenia forbesi, Woods and Duncan.
† Pericosmus sp.*
Cidaroid spines.

Crustacea.

Crab chelæ.
? Balanus 2 spp.

Polyzoa.

Brachiopoda.

Terebratulina catinuliformis ?, Tate.
Magasella compta, G. B. Sowerby.

Lamellibranchiata.

† Ostrea manubriata, Tate.
,, arenicola, Tate.
† ,, sp.

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* Identified by Sir Frederick McCoy.

Placunanomia ione, Gray.
Pecten antiaustralis, Tate.
† ,, polymorphoides, Zittel.
† ,, Zitteli, Hutton.
Modiola, n. sp.
Nucula tenisoni, Pritchard.
,, n. sp., aff. N. morundiana, Tate.
Leda woodsii, Tate.
† ,, crassa, Hinds.
† ,, n. sp. 1.
† ,, n. sp. 2.
Limopsis belcheri, Adams and Reeve.
Pectunculus cainozoicus, T. Woods.
Trigonia acuticostata, McCoy.
Crassatella, n. sp., aff. C. oblonga, T. Woods.
,, n. sp., aff. C. abbreviata, Tate.
Cardita calva, Tate.
,, solida, Tate.
,, compacta, Tate.
† ,, spinulosa, Tate.
,, n. sp.
† Diplodonta suborbicularis, Tate.
† ,, crepidulæformis, Tate.
† ,, n. sp.
† Montacuta sericea, Tate.
† ,, n. sp.
Chione subroborata, Tate.
,, n. sp., aff. C. propinqua, T. Woods.
,, n. sp., aff. C. dimorphophylla, Tate.
† Meretrix paucirugata, Tate.
Dosinia johnstoni, Tate.
Tellina albinelloides, Tate.
,, æquilatera, Tate.
,, n. sp. aff. T. stirlingi.
† Donax, n. sp. aff. D. epidermia.
Mactra hamiltonensis, Tate.
Zenatiopsis angustata, Tate.
Myadora corrugata, Tate.
† ,, brevis, Sowerby.

Corbula ephamilla, Tate.
Barnea tiara, Tate.

Gastropoda.

† Trophon, n. sp.
† Pleurotoma, n. sp. ?
Pelicaria coronata, Tate.
Cassis, n. sp.
Natica varians, Tate.
Calyptræa crassa, Tate.
† Scalaria triplicata, Tate.
Turritella pagodula, Tate.
† Turbo, sp.
Bankivia maxima, Tate, m.s.
Leiopyrga sayceana, Tate.
† ,, quadricingulata, Tate.

Scaphopoda.

Entalis subfissura, Tate.

Pisces.

Shark's teeth.

Mammalia.

Whale bones.

SUMMARY.

Echinodermata - - - -	6
Crustacea - - - - - -	3
Brachiopoda - - - - -	2
Lamellibranchiata - - - -	44
Gastropoda - - - - -	12
Scaphopoda - - - - -	1
Pisces - - - - - -	1
Mammalia - - - - -	1
	70

In the foregoing list the species marked by a dagger (†) are additional to those collected at the Charman's Road end of the section. They are as follows :—

Echinodermata - - - -	4
Lamellibranchiata - - - -	16
Gastropoda - - - - -	5
	25

Total from Charman's Road (not including Tate's and McCoy's records - - - - - - 19

116

In the above 116 records there are fifty-nine described molluscan species of which there are four recorded with a query until better material is obtained. So that for careful and critical comparison with specimens from our other fossil localities we can take into consideration fifty-five species.

Cheltenham Fossils.	Eocene.	Miocene. Muddy Creek.	Miocene. Jenny's Point.	Miocene. South Australia.
Gastropoda.				
Ancillaria orycta, Tate	x	-	x	x
Pelicaria coronata, Tate	-	x	x	-
Cypraea leptorhyncha, McCoy	x	-	-	-
Natica varians, Tate	-	x	x	-
,, substolida, Tate	x	-	x	-
,, subinfundibulum, Tate	x	x	x	-
,, hamiltonensis, Tate	x	-	x	-
Calyptraea crassa, Tate	-	-	x	x
*Crepidula unguiformis, Lamk.	x	x	x	x
Scalaria triplicata, Tate	-	-	x	x
Turritella tristira, Tate	x	-	x	-
,, acricula, Tate	x	-	x	x?
,, pagodula, Tate	-	-	x	-
Leiopyrga sayceana, Tate	-	x	x?	-
,, quadricingulata, Tate	-	x	x	-
Scaphopoda.				
Entalis mantelli, Zittel	x	x	x	-
,, subfissura, Tate	x	x	x	-
Dentalium bifrons, Tate	x	x	-	-
Lamellibranchiata.				
Ostrea arenicola, Tate	-	-	x	x
,, manubriata, Tate	-	x	-	-
*Placunanomia ione, Gray	x	x	x	x
Pecten antiaustralis, Tate	-	x	x	x
,, polymorphoides, Zittel	x	-	-	-
,, zitteli, Hutton	x	x	-	-

Cheltenham Fossils.	Eocene.	Miocene.		
		Muddy Creek.	Jenny's Point.	South Australia.
*Nucula tenisoni, Pritchard - - -	x	x	x	x
Leda woodsii, Tate - - - -	x	x	-	-
* ,, crassa, Hinds - - - -	-	x	x	-
,, acinaciformis, Tate - - -	-	x	-	-
,, vagans, Tate - - - -	x	-	x	-
*Limopsis belcheri, Ad. & R. - -	x	x	x	x
Pectunculus cainozoicus, T. Woods -	x	x	x	-
* ,, laticostatus, Quoy & Gaim.	x	x	x	-
Cucullæa corioensis, McCoy - -	x	x	x	x
*Trigonia acuticostata, McCoy - -	-	x	x	x
Carditella polita, Tate - - -	-	x	-	-
Cardita calva, Tate - - -	x	x	-	-
,, solida, Tate - - - -	-	x	x	-
,, compacta, Tate - - -	x	-	-	-
,, spinulosa, Tate - - -	-	-	x	-
Diplodonta suborbicularis, Tate - -	x	x	-	x
,, crepidulæformis, Tate -	x	-	-	-
Montacuta sericea, Tate - - -	x	x	-	-
Chione subroborata, Tate - - -	-	x	x	x
Meretrix paucirugata, Tate - -	-	x	x	-
Dosinia johnstoni, Tate - - -	-	x	-	-
Tellina albinelloides, Tate - - -	-	x	x	-
,, æquilatera, Tate - - -	x?	x	x	-
Psammobia hamiltonensis, Tate - -	-	x	x	-
Mactra hamiltonensis, Tate - -	-	x	x	-
Zenatiopsis angustata, Tate - -	-	x	x	-
Myadora corrugata, Tate - - -	-	x	x	x
,, prælonga, Tate - - -	-	x	x	-
* ,, brevis, Sowerby - - -	x	x	x	x
Corbula ephamilla, Tate - - -	x	x	x	x
Barnea tiara, Tate - - - -	-	x	x	-

NOTE.—Those marked with an asterisk are living species.

Summary of vertical distribution of described mollusca from the Cheltenham cliffs.

Number of species in above list - -	55
Number of these in Eocene elsewhere	29 (1 doubtful)
Number of these in Miocene—	
Muddy Creek - - -	40
Jemmy's Point - - -	41 (1 doubtful)
South Australia - - -	17 (1 doubtful)
Number hitherto regarded as Eocene only - - - - - -	4*
Number of species common to Eocene and Miocene - - - -	25 (1 doubtful)
Number of species found only in Miocene and younger beds -	26

Beaumaris.

Eocene Fossils (from Limestone Shingle).

Zoantharia.

Placotrochus deltoideus, Duncan.
Notocyathus excisus, Duncan.

Polyzoa.

Brachiopoda.

Waldheimia insolita, Tate.

Lamellibranchiata.

Spondylus pseudoradula, McCoy.

Gastropoda.

Triton cyphus, Tate.
,, gibbus, Tate.
,, textilis ?, Tate.
Peristernia murrayana, ?, Tate.
Voluta hannafordi, McCoy.
,, antiscalaris, McCoy.
,, strophodon, McCoy.
,, sp. 1.
,, sp. 2.

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* *i.e.* except those recorded as Eocene on the strength of their occurrence at Cheltenham only.

Semicassis sufflata, T. Woods.
Cypraea leptorhyncha, Tate.
Conus ligatus, Tate.
,, cuspidatus, Tate.
Genotia angustifrons, Tate
Natica, sp.
Turritella murrayana, Tate.
Cerithium apheles, T. Woods.
Trochoid casts.

Cephalopoda.

Nautilus, sp.

One of the authors has elsewhere recorded thirty-two species of fossils from Cheltenham (11). As uncertainty exists as to the exact horizon from which the greater number were obtained, and as there is evidence that some species, hitherto regarded as Eocene, transgress at Cheltenham into the Miocene, it would, we think, be injudicious to attempt to correct the list there given. The only safe plan is to erase the record by striking out the word "Cheltenham" wherever it occurs in the catalogue. The locality is correct, the horizon may be surmised for most of the forms, but is not absolutely certain.

3. *Ricketts Point.*

Mr. J. A. Atkinson first drew our attention to the fossils occurring in ferruginous beds here. They are not common and as is usually the case are mere casts.

We have found the following:—*Lovenia forbesii*, Wds. and Dunc.; *Leda crassa*, Hinds; *Chione subroborata*, Tate; *Dosinia johnstoni*, Tate; *Tellina albinelloides*, Tate; *Mactra hamiltonensis*, Tate; *Donax*, sp.; *Zenatiopsis angustata*, Tate; *Barnea tiara*, Tate; *Scalaria triplicata*, Tate; *Leiopyrga quadricingulata*, Tate; *L. sayceana*, Tate.

4. *Red Bluff, Sandringham.*

The cliff is about eighty feet in height. The upper portion consists of about sixty feet of mottled sandy clay, which overlies the denuded surface of strongly ferruginous sandstones full of concretionary nodules. We have already mentioned that we do not think that this unconformity indicates any appreciable lapse of time and that the whole cliff belongs to the same period of deposition. The ferruginous beds are well jointed and after keeping fairly horizontal for about 150 yards they slowly sink with a dip of about 7° and pass out of sight, the mottled upper beds coming down to sea-level. In the ferruginous beds there occur small lenticular sheets of a hard grey limestone. In our searches for fossils at this locality we have been kindly assisted by Mr. T. S. Hart and Mr. W. H. F. Hill, who have placed their material at our disposal.

We obtained the following fossils:—*Lovenia forbesii*, Wds. and Dunc.; *Leda crassa*, Hinds; *Chione subroborata*, Tate; *Dosinia johnstoni*, Tate; *Tellina albinelloides*, Tate; *Mactra hamiltonensis*, Tate; *Modiola*, sp. nov.; *Meretrix paucirugata*, Tate; *M. submultistriata*, Tate; *Zenatiopsis angustata*, Tate; *Entalis subfissura*, Tate; *Leiopyrga quadricingulata*, Tate; *L. sayceana*, Tate; *Bankivia maxima*, Tate, m.s.; *Potamides*, sp., *Calyptræa crassa*, Tate.

5. *Hampton* (Picnic Point).

On the point south of the pier the hard ironstone is brought up by a slight roll in the strata, the strike of which is S.25°E., the dip being about 5°. Some of the bands are fairly rich in fossils.

6. *Brighton Beach.*

Casts of fossils occur in ferruginous beds at the mouth of a gully about half-way between Picnic Point and Brighton Beach.

7. *Brighton Beach.*

The point north of the pier at Brighton is formed by an outcrop of brown jointed sandstone passing up into mottled sandy clays. The rocks are slightly current bedded, and though fossils occur they are scarce. The dip as plotted from two observed apparent dips is N.11°E. at 13°.

8. *Brighton Beach.*

The locality is on the same low bluff as seven and on the north side of the point.

9. *Park Street, Brighton.*

Casts are common in ferruginous beds on the beach at the end of a point south of the North Brighton Baths. Mr. T. S. Hart drew our attention to this locality, which he records in his paper (12). *Leda crassa*, Hinds; *Dosinia johnstoni*, Tate; *Mactra hamiltonensis*, Tate; *Leiopyrga sayceana*, Tate; etc.

10. *Bay Street, Brighton.*

Casts in ferruginous sandstones on the beach.

11. *Park Street, Elsternwick.*

This is the most northerly locality in which we have found fossil casts in the beach exposures.

The rocks of Point Ormond (Red Bluff, St. Kilda) do not seem to contain any organic remains which seem to be confined to the deeper seated deposits of the series. A small outlier at the entrance to Kenney's Baths at the end of Fitzroy Street composed of a quartz conglomerate cemented with limonite seems similarly barren. The only sign of the beds to the north of this on the beach is a small patch of shingle near the Middle Park Baths.

12. *Asling Street.*

We found numerous casts in a heap of rock removed during the making of a road which runs from Asling Street towards the beach just before the latter crosses the small creek which runs into the Elwood Swamp. Mr. Hart kindly made enquiries and found that the material all came from the excavation beside which it lay.

Dosinia johnstoni, Tate; *Leda crassa*, Hinds; *Mactra hamiltonensis*, Tate; *Leiopyrga sayceana*, Tate; etc.

13. *North Road.*

Mr. G. Cuming gave us some blocks of fossiliferous ironstone which he obtained from a quarry near the Brighton Cemetery. We have not visited this locality.

Fossils.—*Leda crassa*, Hinds; *Leda*, sp.; *Mactra hamiltonensis*, Tate; *Myadora corrugata*, Tate; *Chione*, sp.? *aff. C. propinqua*, T. Wds.; *Leiopyrga sayceana*, Tate; *Bankivia maxima*, Tate, m.s.

14. *Windsor.*

We carefully examined the Tertiary grits overlying the Silurian in the railway cutting under the Dandenong Road at Windsor, but were not successful in finding any fossils. However, in a collection presented by the Mining Department to the Working Men's College are some samples of a ferruginous sandstone containing a few fossil casts and labelled "Railway Cutting, Windsor." We have no reason to doubt the correctness of the label, as a part of the cutting is now inaccessible owing to a retaining wall having been built.

Fossils obtained :—*Polyzoa* ; *Spondylus pseudoradula*, M'Coy ; *Cardita polynema*, Tate ; *Barbatia simulans*, Tate ; *B. celleporacea*, Tate ; *Lima linguliformis*, Tate ; *L. bassii*, T. Woods ; *Phos tardicrescens* ?, Tate.

15. *South Yarra.*

The low platform of rock left in the angle formed by the junction of the Gippsland and Brighton Railways is in parts very full of casts and we were fortunate in obtaining some large blocks which were very rich and which we carried home bodily for careful examination. Although the fossils are so different from those hitherto dealt with, with the exception of those from Windsor, the lithological character of the matrix is similar to that of the previous sections. We have not found any fossils in the rocks overlying the platform nor have we been able to detect any physical break between them. The upper beds are usually mottled sands, but in places are as strongly cemented by iron as are the lower ones. An examination of the sections along the line towards Hawksburn and towards Prahran does not appear to throw any light on the difficulty. We are inclined, in view of the section in Royal Park, described below, to think that a distinct palæontological break will be yet found and that the upper beds are really a part of the series exposed along the Brighton coast.

Zoantharia.

Coral casts.

Crustacea.

Crab carapace.

Polyzoa.

Brachiopoda.

Waldheimia garibaldiana, Davidson.

Lamellibranchiata.

Placunanomia, sp.
Pecten hochstetteri, Zittel.
,, polymorphoides, Zittel.
Lima bassii, T. Woods.
,, linguliformis, Tate.
Spondylus pseudoradula, McCoy.
Modiola, sp.
Leda vagans ?, Tate.
Pectunculus laticostatus, Quoy and Gaimard.
,, cainozoicus, T. Woods.
Barbatia simulans, Tate.
,, celleporacea, Tate.
Plagiarca cainzoica, Tate.
Limopsis belcheri, Adams and Reeve.
Chione cainozoica, T. Woods.
Cardita polynema Tate.
Chama lamellifera ?, T. Woods.

Gastropoda.

Fusus craspedotus ?, Tate.
Nassa tatei ?, T. Woods.
Lyria harpularia, Tate.
Ancillaria pseudaustralis, Tate.
Conus heterospira, Tate.
Cypræa, sp.
Trivia avellanoides, McCoy.
Semicassis sufflata, T. Woods.
Natica hamiltonensis ?, T. Woods.
Calyptropsis turbinata, T. Woods.
Cerithium flemingtonensis, McCoy.
Liotia roblini, Johnston.
Astralium (Imperator) johnstoni, Pritchard.
Haliotis nævosoides, McCoy.

Scaphopoda.

Entalis mantelli, Zittel.
,, subfissura, Tate.

16. *Domain Road, South Yarra.*

A shaft sunk during the progress of the sewerage works near the Grammar School Chapel, yielded casts of a few gastropods, a small bivalve, some polyzoa and foraminifera. We were unable to determine any of the specimens. The depth at which they were struck was about twenty feet below the level of the South Yarra Railway line, judging by the plans kindly shown us by the overseer of the works. A drab tenacious clay occurred below the ferruginous beds, but did not appear to contain fossils. The sewer itself was driven in Silurian.

17. *Royal Park.*

The Railway Cutting in Royal Park, close to Flemington Bridge, is, from a geological point of view, one of the most interesting and instructive spots in the neighbourhood of Melbourne. At the south-western end beneath the semaphore at the level of the rails is a small exposure of the lowest rocks to be seen in the district, the Upper Silurian. When the cutting was new and the exposure fresh, the bedding planes were distinctly visible, although at the present time the nature of the rock is not so manifest. Flanking this ridge on its south-western side is the older volcanic rock. This is deeply eroded and two or three other exposures of it weathered to a soft, wackenitic clay, are visible in the cutting. In the hollows of its upper surface are pockets of sand and clay. The largest exposure of these rests in its lower part on the north-eastern flank of the Silurian ridge just mentioned and thins out on the volcanic rock. Immediately over the thin sheets of white sand and clay there is a bed about a foot in thickness of similar material cemented with oxide of iron mainly in the form of red ochre, which in places passes into hard hematite.

This band is not separable from the clays and sands on which it rests. The cement penetrates the lower layers irregularly so that at first sight an unconformity suggests itself. This appearance is, however, entirely due to the irregular occurrence of the cementing material. The absence of the cement from the underlying beds may be due to one of two causes. If the iron were ever in the beds it may have been removed by the percolation of meteoric water slowing draining along the old channel in the volcanic rock which affords an impervious bottom. If this were the case we should expect the base of the ferruginous beds to contain limonite and the more hydrated forms of iron oxide. This is, however, not what we do find. The hematite stops suddenly, though in places somewhat irregularly, and is immediately succeeded in depth by the white sands. The other explanation, and the one which we are inclined to accept is that the iron has all come from the beds above and has been prevented from reaching the lower beds by a band of clay through which the water with iron in solution could not percolate.

The presence of the hematite cement which marks off the highly fossiliferous band from the limonite bearing beds above, together with the fact that the characteristic fossils which it contains do not rise over the bosses of volcanic rock, but lie in its eroded hollows, would in themselves afford some slight evidence of its distinctness from the overlying beds. That there is a real break the fossil evidence clearly shows. The fossils of this lower band are Eocene while those of the beds above it are Miocene.

The uppermost beds displayed in the cutting form the table-land of Royal Park. They have been removed by subsequent denudation at the south-westerly end of the cutting where the surface of the ground drops rapidly. The material of which they consist varies from quartz gravel to fine sand with a large proportion of clay. The lower beds of this upper series, as a rule, are more strongly cemented by limonite than are the upper ones, in which the ferruginous material occurs very irregularly. Towards the top of the cutting the beds are in places almost free from iron which has been irregularly removed. Fossils are very scarce, but we have gathered a few forms which are so characteristic that there cannot, to our minds, be any doubt of the horizon to which the beds should be referred. The quarter-sheet records "fossil leaves and fruit in tertiary ferruginous sandstone" from this locality. We have not found any traces of these at this spot but believe them to have come from the upper beds.

Lower Beds (*Eocene*).

Echinodermata.

Psammechinus woodsi, Laube.

? Toxobrissus sp. (also at Schnapper Point, Moorabool Valley and Waurn Ponds).

Cidaroid spines.

Crustacea.

Crab carapace and chelæ.

Polyzoa.

Brachiopoda.

Waldheimia garibaldiana, Davidson.
,, insolita, Tate.

Lamellibranchiata.

*Placunanomia, sp.
Lima bassii, T. Woods.
* ,, linguliformis, Tate.
,, (Limatula) jeffreysiana, Tate.
Spondylus pseudoradula, McCoy.
Nucula tenisoni ?, Pritchard.
*Barbatia celleporacea, Tate.
,, simulans, Tate.
Cucullæa corioensis, McCoy.
Cardita polynema ?, Tate.
* ,, delicatula ?, Tate.
Mytilicardia, sp.
Chione dimorphophylla, Tate.
,, cainozoica, T. Woods.
*Corbula ephamilla, Tate.

Gastropoda.

*Triton, sp.
Fasciolaria rugata, Tate.
Voluta ancilloides, Tate.
,, sp. (? McCoyii, T. Woods).
Pleurotoma paracantha, T. Woods.
Drillia, sp.
Genotia angustifrons, Tate.
Conus ligatus, Tate.
,, heterospira ?, Tate.
Cypræa subsidua, Tate.
,, brachypyga, Tate.
,, sp.
Trivia avellanoides, McCoy.
*Harpa tenuis, Tate
,, n. sp.
Cassis exigua, T. Woods.

*Calyptræa, sp.
Natica, sp.
Solarium, sp.
Scalaria, sp.
Tenagodes occlusus, T. Wds.
*Thylacodes conohelix, T. Woods.
Cerithium flemingtonensis, McCoy.
*Triforis, sp.
Astralium (Imperator) johnstoni, Pritchard.
Turbo flindersi ?, T. Woods.
Opercula of Turbo.
Calliostoma, sp.
Haliotis naevosoides, McCoy.
,, mooraboolensis, McCoy.
*Emarginula, sp. aff. E. candida, A. Adams.
* ,, n. sp. 1.
,, n. sp. 2.
Acmæa, sp. aff. A. costata.

Scaphopoda.

Entalis mantelli, Zittel.

Cephalopoda.

Aturia australis, McCoy.

Note.—The species marked by an asterisk were collected by Mr. A. W. Craig, M.A.

Upper Beds (*Miocene*).

Leda acinaciformis, Tate.
Limopsis belcheri, Adams & Reeve.
Dosinia johnstoni, Tate.
Myadora corrugata, Tate.
Tritonidea brevis, Tate.
Terebra geniculata, Tate.
,, catenifera, Tate.
Turritella, sp.
Pyramidella, sp.
Leiopyrga quadricingulata, Tate.
Liotia, sp.
Entalis subfissura, Tate.

And other indeterminate univalve and bivalve casts.

18. *Sutton Street.*

At the west end of Sutton Street, North Melbourne, an outcrop of white clay is visible along the bank of the swampy land. This is marked on the quarter-sheet and is perhaps one of the localities from which Brough Smyth obtained fossil leaves, as he only gives his locality in a general way. We were unable to find any fossils in the deposit. The beds are well stratified and consist for the most part of white clays which are however very sandy in places, the sand being very coarse. It contains large ferruginous concretions and irregular masses of fine dark coloured translucent flint. Its eroded surface is covered by the older volcanic rock. These clays represent the Miocene of Brough Smyth's section (4).

19. *Flemington.*

At the top of the opposite escarpment across the Moonee Ponds Valley a small excavation yielded a few forms similar to those of the lower beds of the Royal Park cutting.

20. *Brunswick Road.*

The ferruginous grits overlying decomposed volcanic rock in the road cutting to the west of the Moonee Ponds Creek are fossiliferous, though the variety of forms does not seem to be very great. Mr. G. Sweet drew our attention to the occurrence of fossil leaves in some of the upper beds in the cutting, and on a visit in his company we were able to secure evidence of their occurrence.

Placunanomia, sp.
Leda acinaciformis, Tate.
 ,, sp.
Modiola, sp.
Chione, n. sp. aff. C. propinqua, T. Woods.
Cytherea paucirugata, Tate.
Mactra hamiltonensis, Tate.
Zenatiopsis angustata, Tate.
Corbula ephamilla, Tate.
Peristernia approximans, Tate.
Ancillaria pseudaustralis, Tate.

Natica varians, Tate.
Hipponyx antiquatus ?, Lamarck.
Pyramidella, sp.
Leiopyrga quadricingulata, Tate.
,, sayceana ?, Tate.
Emarginula, sp.
Haliotis, n. sp. aff. H. nævosoides, McCoy.

21. *Spring Creek.*

This small creek enters the Saltwater River between Braybrook and Maribyrnong. It flows through plains capped by newer volcanic rock, and has cut through this to the underlying formations. On the quarter-sheet a fault is marked crossing it and lowering the newer to the level of the old volcanic rock in the creek bed. The upper volcanic, wherever it is visible in cliff section in the neighbourhood, is seen to be formed by a very thin flow, and to assume that after faulting the surface had been planed down to its present level contour is hardly, we think, justified. An examination of the locality induced us to form the opinion that the appearance is due, not to faulting, but to the presence of an old valley crossing the present one obliquely. This old valley subsequently became filled with lava which formed the plain. The fossils found were indeterminate.

22. *Green Gully, Keilor.*

The beds in this pretty little glen are indicated on the quarter-sheet and have been briefly alluded to by Mr. Graham Officer (14). Aneroid measurement shows that the depth of the valley where the road crosses it is about 130ft. The section here is approximately as follows, the thickness of the individual beds being estimated :—

Newer volcanic rock - - -	20 feet.
Quartzites and grits - - -	25 ,,
Ferruginous grits (fossiliferous) -	20 ,,
Older volcanic - - - -	65 ,,
	130 feet.

A few yards above the road on the right bank the ferruginous grits are in their lower part replaced by a band of cream coloured, earthy, polyzoal limestone about five feet thick. It is full of foraminifera, echini spines and polyzoa, though, as is usually the case in such rocks, other fossils are scarce. In patches the limestone is altered to a fine grained, hard, reddish rock with a conchoidal fracture. The limestone is immediately succeeded in depth by decomposed volcanic rock seamed with sheets of secondary ironstone. The limestone is very quartzose in places and passes up gradually into ferruginous grit, in which we have not been able as yet to find any fossils.

The alteration of the limestone overlying the volcanic rock here is of interest when taken into consideration with similar developments elsewhere. At Maude the alteration is so pronounced in places that the officers of the survey were led to ascribe it to the effect of an overlying thin sheet of volcanic rock. We have shown in a previous paper (17) that there is no intercalated basalt, and that the appearances which suggest its presence are really due to the deposition of the limestone in the clefts and crannies of a denuded basalt surface. The alteration cannot then have been produced as suggested. In fact the same section shows similar polyzoal limestones overlain by 100 feet of basalt, but no marked changes have been brought about by the flow. We noticed that at Maude the alteration of the rock was most pronounced where it lay on the denuded basalt surface, and became less marked at higher levels, but were quite at a loss to account for it.

Since then we have examined similar altered polyzoal limestones at Airey's Inlet where it lies on the denuded surface of the great basaltic dykes which seam the ash beds and on the ash beds themselves. Again at Point Addis we have the pink finely crystallised limestone passing up into the usual loose-textured polyzoal rock. The limestone rests on a great thickness of remarkable black clays. In the Grange Burn, near Hamilton, we find a similar limestone highly altered and plastered down into the joints and irregularities of the porphyry where the latter crosses the stream. Further removed from the junction of the two formations the alteration is less pronounced. Similar alteration is found in the polyzoal rock overlying ash beds at Curlewis and near Batesford where the granite probably underlies at no great depth.

There is one feature in common to all these cases, and that is the comparative imperviousness of the bed rock, whether it be porphyry, basalt, decomposed ash or sedimentary clay. The typical polyzoal limestone is very open and porous, and it consequently offers a free channel to the passage of underground waters, which would accumulate in them in such localities and thus bring about the solution and redeposition of the calcareous matter and so destroy in places all evidence of organic contents. Mr. A. W. Howitt (18, p. 209), mentions a similar alteration in Devonian limestone, which a previous writer had explained as due to the intrusion of an igneous rock. Mr. Howitt shows that the limestone in question was laid down on a shingly bottom and ascribes the alteration to the infiltration of silica set free during the decomposition of the porphyry beneath.

In the road cutting on the opposite side of the valley the junction of the tertiary beds with the underlying volcanic rock is well displayed. The upper surface of the latter is very uneven and the rock is quite wackenitic. Immediately resting on it is a bed of chocolate-coloured grit about five feet in thickness which yielded us a few fossil casts.

We found *Haliotis nævosoides*, M'Coy, and a shark's tooth, possibly *Lamna.*

This bed is overlain by about four feet of fine grained yellow sandstones which are current-bedded. Over this again come thin beds of water-worn gravel. Over a wide area in this locality overlying the fossiliferous beds we have a bed of sandstone and gravel, which in some places is loose and incoherent, and in others is cemented so as to be a hard white quartzite. The finer varieties look like porcelain. Of the equivalents of the beds over the fossiliferous grits we are uncertain, as we have not been able to get a junction between the two sets. We, however, class them, provisionally, with the Miocene series till further evidence be forthcoming.

Foraminfera.

Echinodermata. Spines and cidaroid plates.

Polyzoa.

Brachiopoda.

Waldheimia garibaldiana, Dav.
Rhynchonella squamosa, Hutton.
Terebratulina scoulari, Tate.

Lamellibranchiata.

Limea linguliformis, Tate.
Pecten foulcheri, T. Woods.
Chione cainozoica, T. Wds.
Chama lamellifera, T. Wds.
Spondylus pseudoradula, M'Coy.

Gastropoda.

Haliotis nævosoides, M'Coy.
Cerithium flemingtonensis, M'Coy.
Conus ralphii, T. Wds.
Trivia avellanoides, M'Coy.
Mitra alokiza, T. Wds.
Turritella murrayana ?, Tate.
Potamides, sp.
Voluta ancilloides, Tate.
Ancillaria pseudaustralis, Tate.
Astralium johnstoni, Pritchard.
Turbo, sp.
Semicassis sufflata T. Wds.
Tenagodes occlusus ?, T. Wds.

Scaphopoda.

Dentalium bifrons, Tate.

Pisces.

Shark's teeth.

Mammalia.

Bones of, ? Whale.

23. *Newport.*

Several bores have been put down and a shaft sunk in search of coal. Particulars of the shaft and one bore, together with samples of the cores, have kindly been placed at our disposal by Mr. G. D. Barker. Details of another bore will be found, together with a locality plan, in the Report of the Secretary for

Mines for 1894. The beds of course vary in thickness in the different localities. The series may be taken as follows:—

1. Newer Volcanic - - - - - - 60 feet
2. Marine Tertiaries. The upper part ferruginous sands and yellow clays, which are unfossiliferous. The lower part yellow and gray clays with hard limestone bands (Eocene fossils) - - - - - 120 feet
3. Estuarine and freshwater beds, composed of sands, clays, fine and coarse conglomerates, with seams of brown coal - - - - 190 feet
4. Silurian (bored into for over 70 ft.).

Most of the fossils recorded were obtained from the spoil heap of the shaft.

Foraminifera.

Very common.

Porifera.

Spicules abundant.

Zoantharia.

Notocyathus, sp.
Flabellum victoriæ, Duncan.
,, candeanum, Edwards & Haime.
Placotrochus deltoideus, Duncan.

Polyzoa.

Very common.

Brachiopoda.

Terebratulina scoulari, Davidson.
Terebratula vitreoides, Tate.

Lamellibranchiata.

Ostrea, sp.
Dimya dissimilis, Tate.
Lima bassii, T. Wds.
Spondylus pseudoradula, McCoy.
* Nucula atkinsoni, Johnston.
,, tenisoni, Pritchard.
Leda huttoni, Tate.
,, obolella, Tate.
,, woodsii ?, Tate.
,, vagans, Tate.

Leda, n. sp.
Limopsis belcheri, Ad. & R.
Arca, n. sp.
Barbatia celleporacea, Tate.
Cucullæa corioensis, McCoy.
Trigonia tubulifera, Tate.
Cardita polynema, Tate.
Chione cainozoica, T. Wds.
Cytherea eburnea, Tate.
Semele krauseana, Tate.
,, vesiculosa, Tate.
Myadora tenuilirata, Tate.
Corbula ephamilla, Tate.
,, pixidata, Tate.
†‡ Capistrocardia fragilis, Tate.

Gastropoda.

Typhis acanthopterus, Tate.
Murex lophoessus, Tate.
Triton textilis, Tate.
,, tortirostris, Tate.
,, woodsii, Tate.
Fusus craspedotus, Tate.
,, acanthostephes, Tate.
‡ ,, senticosus, Tate.
† ,, hexagonalis, Tate.
Latirofusus, sp.
Clavella bulbodes, Tate.
Fasciolaria exilis, Tate.
† Siphonalia, sp., aff. longirostris, Tate.
Phos, ? variciferus, Tate.
Nassa tatei, T. Wds.
Voluta antiscalaris, M'Coy.
,, pseudolirata, Tate.
,, hannafordi, M'Coy.
,, sarissa, Tate.
† ,, strophodon, M'Coy.
Mitra alokiza, T. Wds.
,, ligata, Tate.
Marginella propinqua, Tate.

Marginella wentworthi, T. Wds.
,, micula, Tate.
Ancillaria pseudaustralis, Tate.
,, semilævis, T. Wds.
,, n. sp.
Columbella clathrata, Tate, m.s.
,, 3 spp.
Cancellaria varicifera, T. Wds.
Pleurotomidæ, 19 spp.
Genotia angustifrons, Tate.
Pleurotoma samueli, T. Wds.
Conus dennanti, Tate.
Cypræa leptorhyncha, M'Coy.
Semicassis sufflata, T. Wds.
* Cassidaria gradata, Tate.
Natica hamiltonensis, T. Wds.
,, substolida, Tate.
Xenophora tatei, Cossmann.
Solarium acutum, T. Wds.
Turritella platyspira, T. Wds.
,, murrayana, Tate.
,, acricula, Tate.
,, sp.
Thylacodes conohelix, T. Wds.
Niso psila, T. Wds.
* Odostomia, n. spp. (2).
Cerithium apheles, T. Wds.
,, cribarioides, T. Wds.
‡ ,, ? n. sp.
‡ Cerithiopsis, 2 spp.
Triforis wilkinsoni, T. Wds.
,, n. sp.
† ,, n. sp.
* Actæon, sp.
Ringicula, sp.
Cylichna, 2 spp.

Scaphopoda.

Entalis mantelli, Zittel.
,, subfissura, Tate.
Dentalium aratum, Tate.

Pteropoda.

Styliola rangiana, Tate.

Pisces.

Otoliths.

SUMMARY.

Zoantharia	4
Brachiopoda	2
Lamellibranchiata	25
Gastropoda	82
Scaphopoda	3
Pteropoda	1
Pisces	1
	118

* Species collected by Mr. E. J. Robertson.

† Species collected by Mr. A. E. Kitson.

‡ Species collected by Mr. Graham Officer.

24. *Altona Bay.*

A bore was put down, some particulars of which, with locality plan, are published in the Report of the Secretary for Mines for 1894. Practically the same series of rocks was exposed as at Newport. The thin sheet of volcanic rock however was overlain by about twenty feet of post tertiary rocks, containing an abundance of recent shells. The Marine tertiaries were about 160ft. in thickness. Beneath the freshwater beds, the Government report states that "45ft. 10in. fine white quartz-drift mixed with shells" occurred. Unfortunately no sample of this interesting deposit was sent to the department nor could we find any trace of it when visiting the locality. It was probably too incoherent for a core to be drawn, so that the interesting question as to what the fossils were will probably remain unknown as the bed lies more than twenty feet below the brown coal seam. Silurian was struck at 422 feet.

The small amount of material, which consisted merely of drill cores, which we had to work on prevents the list of fossils from being larger. Some of the beds were very rich, and in some places the core was quite full of siliceous sponge spicules.

Foraminifera.

Excessively abundant.

Porifera.

Spicules very common. The siliceous forms comprise highly compound varieties.

Zoantharia.

Notocyathus excisus, Dunc.
,, australis, Dunc.
Balanophyllia australiense, Dunc.

Echinodermata.

Cidaroid spines.

Annelida.

Ditrupa, sp.

Polyzoa.

Very common.

Brachiopoda.

Waldheimia garibaldiana, Dav.
Terebratula vitreoides, Tate.
Terebratulina scoulari, Tate.

Lamellibranchiata.

Pecten zitteli, Hutton.
,, dichotomalis, Tate.
Lima (Limatula) jeffreysiana, Tate.
Modiolaria singularis, Tate.
Leda vagans, Tate.
,, huttoni, T. Wds.
,, obolella, Tate.
Limopsis belcheri, Ad. & R.
Cucullæa corioensis, M'Coy.
Chione cainozoica, T. Wds.
Cardita delicatula, Tate.
Carditella lamellata ? Tate.
Semele vesiculosa, Tate.
Corbula pixidata, Tate.
Cuspidaria subrostrata, ? Tate.

Gastropoda.

Murex trochispira, Tate.
Triton woodsii, Tate.
,, textilis, ? Tate.
Epidromus tenuicostatus, T. Wds.
Fusus foliaceus, Tate.

Fusus craspedotus, Tate.
Nassa tatei, T. Wds.
Marginella micula, Tate.
,, propinqua, Tate.
,, wenthworthi, T. Wds.
,, n. sp.
Ancillaria semilævis, T. Wds.
Columbella, sp.
Conus heterospira, Tate.
Pleurotoma murndaliana, T. Wds.
Pleurotoma, 3 spp.
Drillia, 3 spp.
Genotia angustifrons, Tate.
Cypræa leptorhyncha, M'Coy.
Cassidaria gradata, Tate.
Turritella platyspira, T. Wds.
,, conspicabilis, Tate.
,, acricula var., Tate.
,, sp.
Tenagodes occlusus, T. Wds.
Eulima, 2 spp.
Cerithium crebariodes, T. Wds.
? Cerithiopsis, sp.
Triforis, sp.
? Astele, sp.
Tinostoma parvula, T. Wds.
Scaphander fragilis, Tate, m.s.
Cylichna, 3 spp.
Ringicula, sp.
Actæon, sp.

Scaphopoda.

Entalis mantelli, Zittel.
,, subfissura, Tate.
Dentalium aratum, Tate.

Pteropoda.

Vaginella eligmostoma, Tate.
Styliola rangiana, Tate.
Spiralis tertiaria, Tate.

Pisces.

Otoliths.

SUMMARY.

Zoantharia	3
Echinodermata	1
Annelida	1
Brachiopoda	3
Lamellibranchiata	15
Gastropoda	42
Scaphopoda	3
Pteropoda	3
Pisces	1
	72

The Geological Structure of the District.

Having now considered the fossiliferous localities of the Tertiary Rocks we shall make a few remarks on the structure of the area.

Upper Silurian.

The bed rock wherever exposed is Upper Silurian. There has been no attempt to work out in the field the stratigraphical relationships of the different fossiliferous outcrops of these rocks, and very little, comparatively, has been published on the organic remains. There is evidence, as will be shown below, that these rocks are intruded by granitoid rocks, and that extensive outcrops of the latter formerly occurred.

The Lower Leaf Beds, and Brown-Coals.

An outcrop of these from under the Older Volcanic Rock at North Melbourne has been noticed above, though, so far, we have found no fossils in it. Brough Smyth records another outcrop at Footscray, and the beds are indicated as occurring near the Industrial Schools in Royal Park.

These beds thicken very much to the south-west where they are represented by the brown-coal deposits of Newport and Altona Bay. The age indicated for the northern members of these beds on the quarter-sheet is Pliocene. Brough Smyth (4) gave reasons for considering them to be Miocene, and his classification is adopted by Murray (7). We have elsewhere (19) given reasons for considering them to be very early Eocene or Cretaceous.

The Older-Volcanic.

We have elsewhere shown that the age of these rocks is Eocene (17). The area covered can be seen on referring to the quarter-sheets, the outcrops being confined to the central and north-western part of the district under consideration.

At Mentone a bore for water was put down which is stated to have reached Silurian at a depth of 583ft. No basalt was found in the bore. Fossils occurred at 86ft.; 150ft.; 235ft.; 253ft.; but none were preserved. We have to thank Mr. G. D. Barker, for the particulars.

At Mordialloc another bore put down for the same purpose in 1887 reached basalt at 223ft., and it was bored into for a distance of 17ft. when operations were suspended.

At Frankston again the Volcanic Rock was struck under tertiaries at a depth of 250ft. (4). It covers a large part of the Mornington Peninsula, and the country to the eastward.

Marine Eocene.

The evidence put forward in the present paper shows that we may consider the following beds as Eocene—the grey clays and limestone of Altona Bay and Newport, the polyzoal limestone and the ferruginous beds indicated at Keilor, the lower beds at Royal Park and those facing them at Flemington, lower beds at South Yarra, ? Windsor, and the unknown beds from which the limestone shingle of the Beaumaris Beach is derived. The deposits at Altona Bay and Newport were unknown to the old survey, while the others were, with perhaps the exception of the polyzoal rock at Keilor, which was merely classed as Tertiary, grouped with the other ferruginous beds as Pliocene. The Eocene beds of Royal Park, Flemington and Green Gully are evidently littoral, while the finer nature of the sediment, and the great abundance of sponge spicules in the deposits at Altona Bay suggest deposition in deeper water.

Miocene.

An examination of the list of fossils from Cheltenham leaves little room for doubt that the deposit must be regarded as of the same age as the upper beds of Muddy Creek and Jemmy's Point.

With the Cheltenham beds must be grouped all the others from which we have recorded fossils in the present paper, with the exception of those above indicated as Eocene. Overlying these beds we have a series of sandstones and gravels which, wherever seen in the district south-east of Melbourne, appear to be inseparable from the underlying fossiliferous Miocene. Towards the north these deposits thin out on the flanks of the Silurian and are probably in the main of freshwater origin. To the south-east they are overlain by the still more recent deposits of Carrum Swamp and reappear beyond its southern boundary. They cover a large part of the northern portion of the Mornington Peninsula, where they can be seen in fine cliff section uncomformably overlying the Marine Eocene. Similar rocks reappear in the Bellarine Peninsula (11). The survey grouped these rocks together and referred them to the Pliocene. At South Yarra, and if the locality reference of the fossils be correct, at Windsor, we have some difficulty in deciding whether the Eocene has or has not, a Miocene cover. Provisionally, however, we may group the superficial rocks of this area with the rest of the Miocene. Similarly to the north and north-west of Melbourne there is, in places, considerable difficulty in separating the Eocene from the Miocene beds. Probably the Eocene does not extend further north than the line from Royal Park to Keilor. As shown by the bores at Altona Bay the Eocene thickens towards the south. It thins out to the north where it is covered by the Miocene which overlaps and runs far inland passing under the basalt plains. The deposit, where not protected by the lava flow has suffered much from denudation, and its material has frequently been redistributed. This great denudation had already progressed far before the outpouring of the Newer Volcanic Rocks, and in some places, as at Northcote Hill, we find an inlier which rises high above the lava plain.

The ferruginous beds, according to Selwyn (1), underlie the lowland between Melbourne and Port Melbourne. The bores to which Selwyn refers were probably put down in connection with the scheme for a canal from Melbourne to the bay and may be the same as the series alluded to by Mr. Henry Ginn (20). Another series, "through the foot of Emerald Hill" by Mr. James Blackburn (20), seems to have proved nothing but the absence of "rock." The Coode Canal does not, as shown by Mr. A. H. S. Lucas, cut through anything but the post-tertiary series (21). There is no evidence to show whether these ferruginous beds under the area in question are Eocene or Miocene, though from the depth at which they were struck, Eocene seems more probable. The same uncertainty prevails about the yellow sands and clays in the upper part of the Altona Bay and Newport shafts.

Taken as a whole, it seems that the Miocene sediments grow finer as we approach the present coast-line. Conglomerates are commoner inland where they cap many of the hills and extend over wide areas. About Brunswick the sections exposed in the brick pits show in places a fairly heavy conglomerate of quartz pebbles. On the Brighton coast the beds are finer in texture and no coarse conglomerates have come under our notice, while the presence of fossil-wood still points to the proximity of land. No marine fossils have been recorded at any great distance from the present coast-line and it seems probable the marine series does not extend far inland, but gives place to a series of terrestrial and freshwater beds.

The thickness of the Marine Miocene does not seem to have been very great. The section exposed in the Beaumaris cliffs does not exceed a hundred feet in thickness and may be taken as indicating approximately the thickness of the series.

The dip of the Miocene beds is very inconstant and is as a rule slight, 5° – 10° being the usual amount, while in one instance, at Beaumaris, the dip is over 20° though only persisting for a short distance. The general strike is about north-west but is somewhat variable. The deeper beds of the series being more ferruginous than the upper ones are more weather-resisting and when brought to the surface on the shore-line form the points which project into the bay. Every little point has either a mass of the ferruginous beds *in situ* for its base or by its beds of shingle shows their near proximity.

The Newer Volcanic Rock.

This is mapped as "Upper Newer Volcanic" and is younger than miocene. Its junction with the underlying ferruginous sands and gravels of probably Miocene age may be seen clearly in a quarry behind the old Flemington Meat Preserving Works on the Saltwater River at Maribyrnong, and in several other escarpments along the Saltwater from here up.

Post Tertiary.

Near the Williamstown Racecourse is a large area covered with marine beds, reaching about 20ft. above sea-level. Mollusca are abundant and seem, as far as we have examined them, to be all living species. The fossiliferous beds of the Yarra Estuary, and the Elwood Swamp, the silt beds of Albert Park, marking an old course of the Yarra towards St. Kilda, and the shell-bearing beds of the Carrum Swamp may be referred to the same epoch.

Capping the Miocene from Elsternwick to Mordialloc recent shells are to be found in places. These have frequently been referred to as indicating a recent subsidence and subsequent upheaval. As far as our observations go the shells are confined to the present coast line, and Mr. T. S. Hart tells us that he is of the same opinion. Their present position is due we think to two causes: the lighter shells have been blown up the slopes by the wind, while the heavier ones may have been carried there by the natives. At Picnic Point, on its northern side, these shells can be traced from sea-level, where the deposit is daily being added to, up the slope to a height considerably above the level of even a "storm beach." If a cliff were cut back here now we should have a similar state of affairs to that which we find commonly along the coast.

Origin of the Sediments.

Silurian rocks have probably yielded the greater part of the Tertiary sediments. In places, however, the sand grains are large and roughened so that the presence of granite in the neighbourhood is probable. Such sands occur south-east of Black Rock. The quarter-sheet states that the Tertiary rocks, near the Toorak Railway Station, rest on "decomposed granite." The bed rock is not now visible about here, so that we cannot discuss this statement. The new edition of the Catalogue of Rocks in the Technological Museum describes a specimen (Nr. I., 79) as "decomposed granite" from the foundations of the Royal Hotel, St. Kilda. The specimen in the Museum is evidently a granitoid rock, but we have not had an opportunity of closely inspecting it.

The sewerage tunnel under Stoney Creek, north of the pumping station, passed through a granitic sand composed of roughened quartz grains, white clay and flakes of black mica. Mr. Spry has shown us similar material from a sewerage shaft near the South Yarra Railway Station. The large sand grains in the clays under the Older Volcanic at North Melbourne seem to suggest a similar granitic origin.*

In conclusion we have to thank numerous friends for information, and for the opportunity of examining fossils from various localities. Mr. T. S. Hart's knowledge of the Brighton district has been of great help. Mr. A. W. Craig has allowed us to carefully examine his large collections from the Eocene of Royal Park. We have also received fossils from various localities from Rev. G. Ramage, Messrs. J. A. Atkinson, A. E. Kitson, J. T. Jutson, E. J. Robertson, Graham Officer, and others, while Messrs. G. D. Barker and Hosie have kindly supplied us with particulars in reference to several bores. Mr. T. W. Fowler has been good enough to survey the cutting in Royal Park for us and to give us the contour of the cutting.

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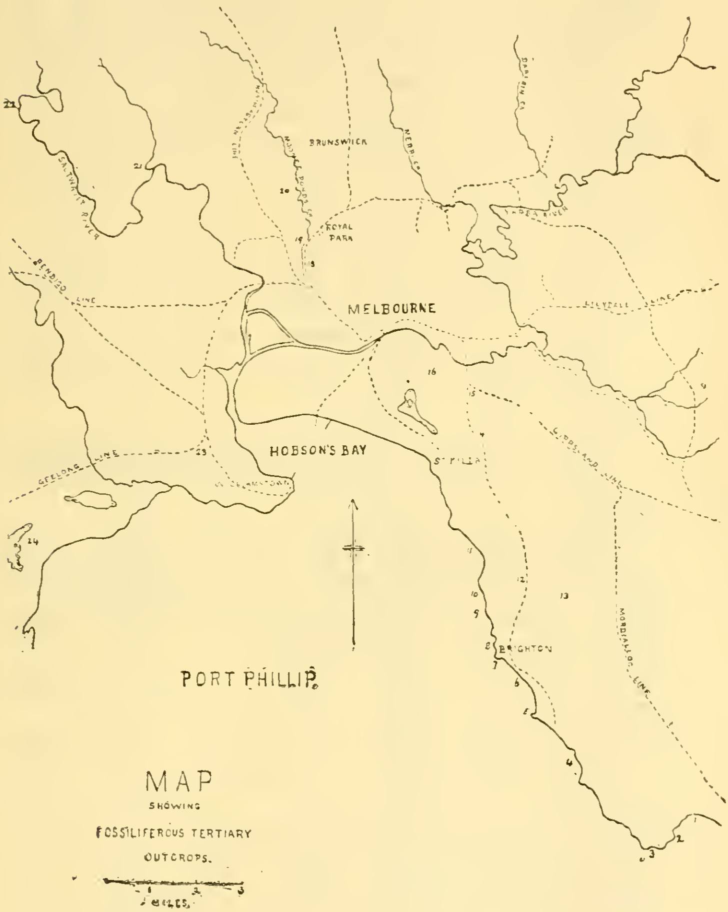
* Since the paper was read Mr. J. A. Atkinson has drawn our attention to the presence of a decomposed coarse granitoid rock in a sewerage shaft at Kensington Road, Toorak. Some hundreds of loads were obtained.

In the Map the figures refer to the fossiliferous localities as numbered in the body of the paper.



EXPLANATION OF PLATE VIII.

Railway cutting in Royal Park. The measurements were made along the south-east side. North-east end to left.

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CUTTING in ROYAL PARK.

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